UNIVERSITI PUTRA MALAYSIA

THE USE OF A GEOGRAPHICAL INFORMATION SYSTEM (GIS) AS A SPATIAL DECISION SUPPORT SYSTEM: PROCESSING PLANNING APPLICATIONS IN HILLY AREAS

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THE USE OF A GEOGRAPHICAL INFORMATION SYSTEM (GIS) AS A SPATIAL DECISION SUPPORT SYSTEM: PROCESSING PLANNING APPLICATIONS IN HILLY AREAS

By

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Decision-making pertaining to development control has been increasingly complex as urbanization extends into environmentally sensitive hilly areas. Coupled to that, the traditional data analysis method of sieving maps is very cumbersome and inefficient for processing planning applications. Here a Geographical Information System [GIS] is seen as the ideal tool of the information age to improve the current inadequacies of the present planning system. Henceforth, the study aimed to adapt GIS as a decision support tool for processing planning applications specifically, in hilly areas.

The study methodology basically involved the identification of a problem statement, formulation of goal and objectives, literature review on the application of GIS in local planning, the development of a planning data model and the design of a planning expert system. The planning data model

consolidated relevant data for processing potential development in hilly areas. Hence, it was structured into common groups namely town planning, administration, utilities, environment and transportation. The principle object behind data analysis was to query site suitability and to determine whether the detailed proposals conformed to planning requirements. To aid decision-making, the decision support system employed a planning expert system. The knowledge base rules of the planning expert system incorporated planning guidelines development in hilly areas. An inference engine consisted of various scripts based on Boolean argument was designed to enable comparative assessment between detail proposals and planning parameters and provided technical advice to support or reject an application. A customised pull-down menu was designed to simplify data query and data retrieval.

The study found that although GIS was effective at data analysis, for the moment, it would be of limited success in processing planning applications because there are many types of planning issues to consider. This would require further development of GIS analytical techniques before it could comprehensively process planning applications. The expert system while effective, depended on a standard format to process layout plans. Overlaying regularly used for data analysis but proved more effective when combined with other techniques e.g. buffering or spatial analysis. Although planning criteria were available, they had to be reviewed to weed out ambiguous

terminologies. Attributes tables were vital to ensure the expert system worked because the inference engine is critical where data are kept. Since GIS was in various stages of implementation, it was concluded GIS could serve as a decision support system for processing planning applications in hilly areas.

Further research was still required to develop new planning expert systems in various sectoral studies e.g. transportation planning. This included the development of digital supporting database, expansion in the scope and depth of data analysis, development of planning design models, fine-tuning planning criteria and the establishment a uniform digital format for the preparation of layout plans.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

KEGUNAAN SISTEM MAKLUMAT GEOGRAFI (SMG) SEBAGAI SISTEM SOKONGAN SPATIAL BAGI TUJUAN MEMBUAT KEPUTUSAN: MEMPROSES PERMOHONAN PERANCANGAN DI KAWASAN BERBUKIT

Oleh

ABBAS BIN ABDUL WAHAB

Jun 2001

Pengerusi : Profesor Madya Dr. Shattri b. Mansor

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Tindakan membuat keputusan [*decision-making*] berhubung kawalan perancangan semakin rumit apabila perkembangan pembangunan urbanisasi menembus kawasan-kawasan berbukit yang sensitif pada kesan alam sekitar. Tambahan pula, teknik penganalisis data secara tradisional melalui pertindihan peta-peta menyulitkan dan kurang berkesan. Dalam era informasi, Sistem Maklumat Geografi [SMG] merupakan alat paling sesuai bagi memperbaiki kelemahan-kelemahan sistem perancangan. Oleh sedemikian, kajian ini berhasrat menyesuaikan SMG sebagai alat sokongan membuat keputusan semasa memproses permohonan perancangan khususnya di kawasan berbukit.

Methodologi kajian melibatkan pengenalpastian kenyataan masalah, pengubalan matlamat dan objektif, kajian ilmiah SMG di bidang perancangan

tempatan, penyediaan modul dan rekabentuk sistem kepakaran perancang. Modul ini menkonsolidasi data-data relevan bagi tujuan memproses pembangunan di kawasan berbukit. Oleh itu, modul demikian membahagikan kategori mengikut kumpulan perancangan bandar, pentadbiran, utiliti, alam sekitar dan pengangkutan. Pokok di sebalik analisis data adalah untuk menentukan sama ada kesesuaian tapak adalah sesuai dari sudut pembangunan dan sama ada cadangan terperinci dapat menampung keperluan teknikal perancangan bandar. Sistem kepakaran perancang telah digunakan dimana ilmu kepakaran merupakan garispanduan perancangan kawasan berbukit. Selain dari itu, engin *inference* merangkumi beberapa skrip berasas teori Boolean untuk membolehkan analisis data antara candangan terperinci dan parameter perancangan. Ulasan teknikal seterusnya disediakan berbentuk kenyataan menyokong atau menolak permohonan. Akhir sekali, *interface* pengguna dalam bentuk *menu* disediakan bagi memudahkan pamparan data.

Walaupun SMG sungguh berkesan bagi tujuan menganalisis data, kajian mendapati ianya hanya sesuai bagi kes-kes yang ringkas dan jelas. Sistem kepakaran didapati berkesan akan tetapi memerlukan format tertentu untuk membolehkan pemerosesan pelan susunatur. Teknik menindihkan peta-peta biasa diguna untuk penganalisis data akan lebih berkesan dengan penggunaannya bersama lain-lain teknik seperti bufer dan analisis spatial. Walaupun kriteria perancangan telah pun sedia ada, terdapat definisi-definisi

kabur yang perlu di jelaskan lagi. Kajian juga mendapati jadual attribut amat penting bagi memastikan sistem kepakaran berfungsi dengan baik akan tetapi kedudukan lokasi untuk menyimpan data sungguh kritikal.Penggunaan SMG adalah hanya diperingkat awal tetapi kesimpulannya, SMG boleh digunapakai sebagai sistem sokongan membuat keputusan semasa memproses permohonan perancangan di kawasan berbukit. Namun demikian, kajian tambahan harus diadakan untuk menyedia perisian maklumat berjenis digital, meluaskan skop dan perincian penganalisan maklumat, rekaan modul perancangan, kajiansemula definisi bagi kriteria perancangan dan penubuhan format seragam bagi pelan susunatur.

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Abbas bin Abdul Wahab

I certify that an Examination Committee met on 14th June 2001 to conduct the final examination of Abbas bin Abdul Wahab on his Master of Science thesis entitled "The Use of a Geographical Information System [GIS] as a Spatial Decision Support System: Processing Planning Applications in Hilly Areas" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirement for the degree of Master of Science.

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledge. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

Name: Abbas bin Abdul Wahab

Date: 30/7/2001.

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LIST OF ABBREVIATIONS

DSS	Decision Support Systems
EIA	Environment Impact Assessment
ERA	Environment Risk Assessment
ES	Expert System
ESCAP	Environmental Sediment Control Plan
ESRI	Environmental Systems Research Institute
GIS	Geographical Information System
JPBD	Federal Department of Town and Country Planning
IT	Information Technology
KLIA	Kuala Lumpur International Airport
LAN	Local Area Network
MSC	Multimedia Super Corridor
PNTPPD	Preservation of the Natural Topography on Planning and Physical Development
RSO	Rectified Skewed Orthomorphic
SDSS	Spatial Decision Support System
SmartMAP	Local Authority Information System
SQL	Standard Query Language

CHAPTER I

INTRODUCTION

1.1 Background

Malaysia's aspiration to become a fully developed nation is contained in its primary goal of Vision 2020. Vision 2020 stress the need for economic development with equity and also emphasizes environment be developed carefully to achieve a sustainable community. To materialise Vision 2020, Zainuddin [1995] formulated a comprehensive, universal planning doctrine called the "Total Planning Doctrine". It basically suggests that planning needs to attain a balance and sustainable development economically, socially, spiritually and environmentally. This means that one of the most important task town planners have to address when processing planning applications to strike a balance between physical development and conservation. Decision-making in development control therefore is a very sensitive issue and calls for sound technical judgement to approve or reject a planning application. However, the task of providing technical advice is made difficult because of current inadequacies in Peninsular Malaysia's planning system. Zainuddin [1997] stated that to overcome these problems, it was timely to access decision support information system in the process of development planning.

1.2 Planning and GIS

The current method of processing planning applications practised by most local planning authorities, unfortunately, is still manual. As a result, many problems arise for e.g., spatial analysis is carried out through sieving various types of sheet plans. There are many to consider and are inconveniently large, often old, vulnerable or tattered around the edges. Lack of technical manpower hampers the updating of these plans. Copies of approved layout plans eventually are glued onto respective sheet plans to indicate changes in land use zoning while the ever changing utility reserves and highway networks are tentatively outlined in pencil to outline areas committed for development. Layout plans need to be meticulously inspected to ensure planning standards are conformed and no errors overlooked. Processing layout plans is also tedious because many types of planning guideline and planning standards have to be considered. As a result, local planning authorities end up with backlogs.

There is a need to change from the traditional method of processing planning applications to modern information technology [IT] techniques to ensure that it is adaptive to changing requirements of the times, at the same time, making it more effective, efficient and productive. Here, the Geographical Information System [GIS] is seen as a most appropriate tool of the IT age to enhance the effectiveness of

processing planning applications. Some benefits GIS has over the traditional information system include the following:

i. GIS can effectively store huge volumes of spatial data and can be further linked to respective textual data to extract relevant information;
ii. GIS is electronically executed and is ideal for mundane and repetitive tasks which increases the probability of human error; and
iii. GIS excels in providing impressive desktop presentations and desktop publishing capabilities as well as suitable for data analysis.

Other than that, GIS is also compatible with town planning because both share some common denominators:

i. Both deal with geography and land issues;
ii. Both deal with maps and plans;
iii. Both deal with a large volume of data; and
iv. Both are associated with problem solving.

Whilst Hall [1996] recommended the use of GIS because it is capable of integrating geographical data with other data from various sources to provide information necessary for decision-making in

planning sustainable development, Hastings [1996] supported GIS for its ability to analyse and manipulate all sorts of data for a variety of purpose and implications.

1.3 Problem Statement

Urbanization with its wide coverage of sectoral issues makes it more complex for town planners to process planning applications. Consequently, there is a need to ensure that all spatial and supporting non-spatial data are efficiently managed to assist decision-making in planning. Technological development in construction make it possible for more projects to be constructed in a shorter time span, thus in the same time span, planners have to process more applications than previously before. The more literate society also expects planning decisions to be better technically justified. As the sharing of common data intensifies, data analysis by sieving maps adds to delays.

The above issues highlight the some of the key problems facing town planners in the local authority and why GIS is being sought to improve or enhance over the traditional manual approach of processing planning applications as well as to assist the local planning authority in decision-making.

1.4 Goal

The study hoped to identify how GIS could guide decision-making in development control pertaining to development in environmentally sensitive hilly areas. As such, the goal of the study was

"To prove that GIS can function as a spatial decision support tool for processing planning applications in hilly areas".

1.5 Objectives

The study aimed to achieve the following objectives:

i. To develop a spatial decision support tool by GIS comprising of a planning data model and a planning expert system to aid processing planning applications in hilly areas;
ii. To identify how GIS techniques are suitable for processing planning applications in hilly areas.
iii. To determine how planning criteria could merge with the planning expert system and assist decision-making; and
iv. To identify factors that expedite GIS in processing planning applications.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

The age of computers is said to be synonymous with the age of information. As computers become cheaper over the years, information can be made more accessible to the people. In the development of the IT industry, GIS is recognised as a very powerful tool that can adapt to a variety of specialised fields. This malleable quality and capability to analyse data, further encouraged as technology progresses makes computers more popular. Burrough [1986] associated GIS as a set of tools for collecting, storing, retrieving, transforming and displaying spatial data from the real world while Cowen [1999] saw GIS as a system of hardware, software and procedures designed to support the capture, management, manipulation, analysis, modelling and display of spatially-referenced data for solving complex planning and management problems. For the full potentials of the GIS to be realised, supporting database must be made available. It is anticipated that once that has been adequately acquired through the conversion of data, GIS will eventually extend as a decision supporting system. Such a system will be practical as it simplifies the task of decision-making through the aid of an expert system that incorporates values of the human expert.

2.2 Applying GIS to Town Planning

Traditionally, town planning has been concerned with the improvement of the social conditions in towns and cities in order to eradicate the many social ills of inadequate and inappropriate living conditions. Ratcliffe [1975] stated that planning serves as reconciliation between conflicting objectives. This situation is most visible in areas of rapid urbanisation where the delicate task of balancing development and growth with conservation is an encounter local planning authorities face when processing planning applications. Such situation calls for decision-making to determine the best choice between alternative options. However, development control is tedious and time-consuming because it represents a multiple-disciplinary process requiring input from various technical agencies and involves a wide range of information. Proposals have to be crosschecked for site suitability, conformity to planning policies, planning guidelines, standards and requirements as well as for compatibility with adjacent land-uses. To strengthen current inadequacies of the planning system, new techniques based on new technology are considered.

Ahris [1997] supported GIS for town planning and stated it is valid and generally aids strategic planning of an organisation in the implementation and monitoring of development projects. He identified five specific areas: